

FORM PTO-1390  
(REV. 9-2001)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

TRANSMITTAL LETTER TO THE UNITED STATES  
DESIGNATED/ELECTED OFFICE (DO/EO/US)  
CONCERNING A FILING UNDER 35 U.S.C. 371

3276.1002000

U.S. APPLICATION NO. (If known, see 37 CFR 1.5

10/031357

INTERNATIONAL APPLICATION NO.  
PCT/DK00/00417INTERNATIONAL FILING DATE  
21 July 2000  
(21.07.00)PRIORITY DATE CLAIMED  
21 July 1999  
(21.07.99)TITLE OF INVENTION A METHOD OF CONTROLLING THE TEMPERATURE OF A SPECIMEN IN OR ON  
A SOLID SUPPORT MEMBER

APPLICANT(S) FOR DO/EO/US

Lars Winther and Kim Adelhorst

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☐ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☐ is attached hereto (required only if not communicated by the International Bureau).
  - b. ☒ has been communicated by the International Bureau.
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
  - a. ☐ is attached hereto.
  - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
  - a. ☐ are attached hereto (required only if not communicated by the International Bureau).
  - b. ☐ have been communicated by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☒ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☒ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

## Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☒ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☐ Other items or information:

U.S. APPLICATION NO. (if known) <b>10/031357</b>		INTERNATIONAL APPLICATION NO. PCT/DK00/00417		ATTORNEY'S DOCKET NUMBER <b>3276.1002000</b>	
--	--	---	--	---	--

<b>21. <input checked="" type="checkbox"/> The following fees are submitted:</b> <b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):</b> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... <b>\$1040.00</b>  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... <b>\$890.00</b>  International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... <b>\$740.00</b>  International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... <b>\$710.00</b>  International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) ..... <b>\$100.00</b>  <b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>				<b>CALCULATIONS PTO USE ONLY</b>          <div style="display: flex; justify-content: space-between;"> <span>\$</span> <span><b>890.00</b></span> </div>	
Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).					
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	39- 20 =	19	x <b>\$18.00</b>	\$	<b>342.00</b>
Independent claims	3 - 3 =	0	x <b>\$84.00</b>	\$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ <b>\$280.00</b>	\$	
<b>TOTAL OF ABOVE CALCULATIONS =</b>				\$	<b>1232.00</b>
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				\$	
<b>SUBTOTAL =</b>				\$	
Processing fee of <b>\$130.00</b> for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
<b>TOTAL NATIONAL FEE =</b>				\$	<b>1232.00</b>
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). <b>\$40.00</b> per property +				\$	
<b>TOTAL FEES ENCLOSED =</b>				\$	
				<b>Amount to be refunded:</b>	\$
				<b>charged:</b>	\$

a. ☒ A check in the amount of \$ 1232.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. \_\_\_\_\_ in the amount of \$ \_\_\_\_\_ to cover the above fees.  
 A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any  
 overpayment to Deposit Account No. 08-0380. A duplicate copy of this sheet is enclosed.

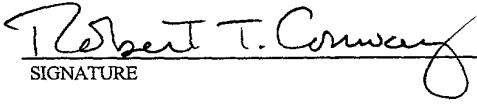
d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card  
 information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR  
 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Robert T. Conway, Esq.  
 HAMILTON, BROOK, SMITH & REYNOLDS, P.C.  
 530 Virginia Road  
 P.O. Box 9133  
 Concord, Massachusetts 01742-9133

  
 SIGNATURE  
  
Robert T. Conway  
 NAME  
  
33,859  
 REGISTRATION NUMBER

IN THE UNITED STATES RECEIVING OFFICE (RO/US)  
Designated/Elected Office (DO/EO/US)

U.S. National Phase of

International Application No.: PCT/DK00/00417  
International Filing Date: 21 July 2000  
Earliest Priority Date: 21 July 1999  
Applicants: Lars Winther and Kim Adelhorst  
Title: A METHOD OF CONTROLLING THE  
TEMPERATURE OF A SPECIMEN IN OR  
ON A SOLID SUPPORT MEMBER  
Attorney's Docket No.: 3276.1002-000

Date: 17 January 2002  
EXPRESS MAIL LABEL NO. EV005369203US

PRELIMINARY AMENDMENT

Box PCT  
Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

Please amend the above-identified application as follows:

In the Specification

On page 1, following the title, please insert the following paragraph:

--RELATED APPLICATIONS

This application is the U.S. National Phase Application of International Application No. PCT/DK00/00417, filed on July 21, 2000, designating the United States and published in English. The International Application claims priority to Danish

Application No. PA 1999 01044, filed July 21, 1999, the contents of which is incorporated herein by reference in its entirety.--

In the Claims

Please cancel Claims 1-35.

Please add the following claims.

36. (New) A method for controlling the temperature of a biological specimen in indirect contact with a solid support member by using induction heating, said specimen being fixed to a carrier or said specimen being in liquid form in contact with a carrier onto which capture probes for capturing said specimen are fixed, and said carrier being removably placed in, on, or under said support member, said solid support member includes a cartridge for a carrier or a cover plate for a carrier and comprising a conducting material, said conducting material being in contact with a layer of heat conducting material, which said heat conducting material is in contact with the specimen, and said method comprising a step of subjecting said solid support to an oscillating magnetic field.
37. (New) A method according to claim 36, wherein said solid support member includes a cartridge having a chamber encompassed by a cartridge wall, said carrier carrying said specimen or said capture probes being placed in said chamber and said chamber being subjected to a magnetic field, said chamber includes at least one access opening for introducing the carrier, and for passing a processing fluid into and out of the chamber.
38. (New) A method according to claim 37 wherein said conducting material includes the form of a solid piece of conducting material placed on the inner side of said cartridge wall, or the form of one or more solid pieces or particles of conducting material incorporated in the wall of said cartridge.

10031357-011702

39. (New) A method according to claim 37, wherein said carrier includes a microscope slide, said cartridge comprising a chamber, and at least one access opening for introducing and withdrawing said slide, and having at least one opening for passing a processing fluid into and out of the chamber, said microscope slide is placed in said chamber, and bears said specimen or said capture probes.
40. (New) A method according to claim 36, wherein said solid support member includes a cover plate for a microscope slide, said cover plate comprising an electric conducting material, said specimen or said capture probes being fixed onto said microscope slide and placed between said cover plate and said slide when subjecting said solid support to an oscillating magnetic field.
41. (New) A method according to claim 36, wherein the electrically conducting material includes a metal.
42. (New) A method according to claim 41, wherein said metal is selected from a group consisting of iron, carbon steel, stainless steel, brass, copper, aluminum, silver, gold, platinum, nickel, zinc, pewter and alloys thereof.
43. (New) A method according to claim 36, wherein the conducting material is in the form of one or more plates, having a length, a width, and a thickness, said length and said width being at least ten times the thickness.
44. (New) A method according to claim 36, wherein the electrically conducting material is in the form of powder incorporated in a polymer material, the amount of powder being sufficiently high to raise the temperature of the specimen when the solid support is subjected to the oscillating magnetic field.
45. (New) A method according to claim 44, wherein said specimen is in the form of a solid specimen, preferably a tissue section or a section of cell blocks.

46. (New) A method according to claim 36, wherein said solid support includes an amount of electrically conducting material sufficiently high to raise the temperature of the specimen when the solid support is subjected to the oscillating magnetic field.
47. (New) A method according to claim 36, wherein said magnetic field is generated by use of an electromagnetic inductor having an induction coil and a power supply, and directing alternating current through said coil.
48. (New) A method according to claim 47, wherein said power supply includes an alternating current power supply.
49. (New) A method according to claim 47, wherein said alternating current includes a frequency in the range of between 1 Hz and 500 kHz.
50. (New) A method according to claim 47, wherein alternating current is delivered through said coil in an amount of power up to about 100 W.
51. (New) A method according to claim 36, comprising a step of heating the specimen to a temperature in the range of between 25 and 110 °C.
52. (New) A method according to claim 36, wherein the specimen is heated and maintained at a constant temperature for a period in the range of between one minute and up to one week.
53. (New) A method according to claim 36, wherein the specimen is dried or fixed or both at an elevated temperature.

54. (New) A method according to claim 36, wherein the specimen is subjected to a reaction step at an elevated temperature, said reaction step includes one or more of the steps capturing the specimen, baking the specimen, exposing the specimen to antigen retrieval, denaturing the specimen, hybridizing the specimen, dewaxing the specimen and washing the specimen.
55. (New) A method for carrying out an automatic or semi-automatic assay of one or more specimens each fixed on a microscope slide, comprising the steps of:
- i) placing the microscope slide in a cartridge comprising a chamber encompassed by a cartridge wall having an inner side, said cartridge comprising an electrically conducting material in the form of a solid piece of conducting material placed on the inner side of said cartridge wall, or in the form of one or more solid pieces or particles of conducting material incorporated in the wall of said cartridge; and
  - ii) placing the cartridge in an induction coil and sending alternating current through said coil to generate a magnetic field.
56. (New) A method according to claim 55 including an automatic or semi-automatic assay of two or more specimens, comprising the additional steps of:
- iii) placing each microscope slide individually in a cartridge including a chamber encompassed by a cartridge wall, said cartridge comprising an electrically conducting material in the form of a solid piece of conducting material placed on the inner side of said cartridge wall, or in the form of one or more solid pieces or particles of conducting material incorporated in the wall of said cartridge; and
  - iv) placing each cartridge individually in an induction coil and sending alternating current through said coil to generate a magnetic field.
57. (New) A solid support member in combination with a carrier for a specimen or capturing probes for a specimen for testing or treating a specimen of biological material, said support member comprising an electrically conducting material on the surface turning against the side of the carrier carrying the specimen.

10031357 011702

58. (New) A solid support member in combination with a carrier according to claim 57, said support member being at least partly of a polymer material selected from a group consisting of polystyrene, polyethylene, polyurethane, polyethylene terephthalates, polyvinyl acetate, polyvinyl chloride, polyvinyl-pyrrolidone, polyacrylonitrile, polymethyl-methacrylate, polytetrafluoroethylene, polycarbonate, poly-4-methyl-pentylene, polyester, polystyrene polypropylene, cellulose, nitro-cellulose, starch, polysaccharides, natural rubber, butyl rubber, styrene butadiene rubber, silicone rubber and copolymers and mixtures thereof.
59. (New) A solid support member in combination with a carrier according to claim 58, wherein an electrically conducting material is incorporated into the polymer material of the support member.
60. (New) A solid support member in combination with a carrier according to claim 59, wherein the electrically conducting material is in the form of powder incorporated in the polymer material, the amount of powder and the particle size of the powder being sufficiently high to provide the material with electrically conducting properties.
61. (New) A solid support member in combination with a carrier according to claim 57, wherein the electrically conducting material includes a metal.
62. (New) A solid support member in combination with a carrier of claim 61, wherein said metal is selected from a group consisting of iron, carbon steel, stainless steel, brass, copper, aluminum, silver, gold, platinum, nickel, zinc, pewter and alloys thereof.
63. (New) A solid support member in combination with a carrier according to claim 57, wherein the electrically conducting material is in the form of one or more plates, having a length a width and a thickness, said length and said width being at least ten times the thickness.

10034357 04702



64. (New) A solid support member in combination with a carrier according to claim 57, wherein said solid support includes between 10 and 100,000 mg of an electrically conducting material.
65. (New) A solid support member in combination with a carrier according to claim 57, wherein the support member includes a cover plate for a microscope slide or a cartridge for a microscope slide.
66. (New) A solid support member in combination with a carrier according to claim 65, wherein said solid support member is a cartridge including a chamber for receiving the carrier with the specimen or the probes for a specimen, and having at least one access opening for introducing the carrier, and for passing a processing fluid into and out of the chamber, said conducting material being in the form of a solid piece of conducting material placed on the inner side of said cartridge wall, or in the form of one or more solid pieces of particles of conducting material incorporated in the wall of said cartridge.
67. (New) A solid support member in combination with a carrier according to claim 66, wherein said conducting material being in the form of a solid piece of electrically conducting material placed on the inner side of said cartridge wall and said cartridge wall includes an opening allowing direct access to the solid piece of electrically conducting material.
68. (New) A solid support member in combination with a carrier according to claim 65, wherein said carrier includes a microscope slide.
69. (New) A solid support member in combination with a carrier and an electromagnetic inductor, said support member being a support member according to claim 57 and said electromagnetic inductor being able to generate a magnetic field.

2025-01-17 10:45:45

70. (New) A solid support member in combination with an inductor according to claim 69, wherein said inductor comprises an induction coil and a power supply, said coil, preferably being sufficiently large to surround the support member, and said power supply being able to sending alternating current through said coil.
71. (New) A solid support member according to claim 70, wherein said power supply includes an AC power supply.
72. (New) A solid support member according to claim 71, wherein said AC power includes a frequency in the range of between 1 Hz and 500 kHz.
73. (New) Use of a support member in combination with an inductor according to claim 69 for treatment of a biological specimen.
74. (New) Use of a support member according to claim 73 for immunohistochemical procedures or *in situ* hybridization.

REMARKS

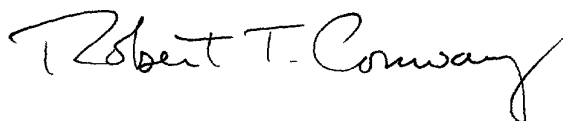
Claims 1-35 have been canceled. Claims 36-74 have been added and are pending. New Claims 36-74 have been drafted to eliminate multiple dependencies in the claims and to eliminate typographical errors in spelling that were present in Claims 1-35.

-9-

Applicants' Attorney hereby authorizes the Patent Office to charge any additional fees to Deposit Account No. 08-0380. A copy of this letter is enclosed for accounting purposes.

Respectfully submitted,

HAMILTON, BROOK, SMITH &  
REYNOLDS, P.C.



Robert T. Conway  
Registration No. 33,859  
Telephone: (978) 341-0036  
Facsimile: (978) 341-0136

Dated: *January 17, 2002*  
Concord, Massachusetts 01742-9133

10031357 01102  
2002/01/17

A method of controlling the temperature of a specimen in  
or on a solid support member

10031357.61102  
202719.25ET001

The present invention relates to a method of controlling  
5 the temperature of a biological specimen during a testing  
step. The first aspect of the invention relates to a  
method wherein the specimen is fixed to a carrier such as  
a microscope slide or the specimen is in liquid form in  
contact with a carrier onto which capture probes for  
10 capturing the specimen are fixed. The carrier is placed  
in, on, or under a solid support member. The invention in  
its first aspect also relates to a solid support member,  
a solid support member in combination with a carrier, a  
solid support member in combination with an inductor and  
15 use of this solid support member. The second aspect of  
the invention relates to a method wherein the specimen is  
fixed to one or more metal containing beads or said  
specimen being in liquid form in contact with one or more  
metal containing beads onto which capture probes for  
20 capturing said specimen are fixed. The invention also  
relates to the beads and the use of the beads.

Throughout the world, there is an increasing demand for  
examining or studying samples of different types, in  
25 particular biological samples such as tissue sections, cell  
smears, cytopspins, sections of cell blocks, molds, fungi,  
bacilli, fine needle aspirates and solutions containing  
macromolecules such as proteins, deoxyribonucleic acids and  
ribonucleic acids. Such samples or specimens are usually  
30 examined by placing the specimen in or on a solid carrier  
and subjecting the specimens to a number of treatments,  
where after the sample is examined using a microscope or  
other analytical instruments or apparatus able to detect  
and/or quantify the presence of particular components, e.g.  
35 specific cells, cell types, or cell components, and/or  
particular compounds, e.g. specific macromolecules like

proteins, deoxyribonucleic acid and ribonucleic acid sequences, polysaccharides, etc., in the samples.

The solid supports or carrier generally used are microscope  
5 slides, microtiter plates or any other type of cartridges  
or test tubes. Normally, the specimen or the capturing  
probes with or without the captured specimen should remain  
on or in the support during the treatment procedure, and  
consequently it is important that the solid support is  
10 shaped depending on the type of treatment necessary for a  
specific test. Many assays involve a sequence of reaction  
steps, which should be carried out under thermostatic  
conditions, and/or reaction steps involving adding a  
reagent, allowing it to react for a persecuted time, and  
15 drying of the specimen. In other situations an assay may  
involve a direct step of heat treatment.

Temperature regulations or control systems for cartridge or  
other solid supports are generally known in the art. In  
20 most of the systems the temperature is regulated using hot  
air, warm water or heat conducting elements being brought  
into contact with the support member.

WO 92/01919 relates to an apparatus for automatic tissue  
25 staining for immunohistochemistry, said apparatus  
comprising a carousel carrying a number of microscope  
slides, each bearing a sample. The carousel is adapted to  
be heated, preferably from beneath, utilising hot air or  
warm water.

30 WO 97/03827 relates to an automated slide staining system  
for cytology or histology specimens, said system comprising  
a heating station provided by a convector, conducting heat  
to the slides. US Patent No. 5,232,667 describes a  
35 temperature control system using conductive heater means  
for heating samples in cartridges.

10034357 017292

The above described temperature systems are generally very slow, meaning that it requires a relative long time to heat the specimens. Also the fact that all of the sample holders should be contacted with the conductive heater, the water or the hot air makes the systems very cumbersome. Furthermore, heating with air or water requires large space and increases the risk of contaminating the specimen with dirt or unwanted microorganisms.

WO 94/23326 relates to a microscope slide holder used for uniform processing of the slides. In this patent publication, it is suggested that the heating step is carried out in a suitable oven. This method also requires large space, and since the heat treatment often is carried out several times during an assay, this method is not suitable in most assays. Heating an oven also requires a lot of energy, which is both expensive and unnecessary if only a few samples should be subjected to the change the temperature of the specimen.

It has also been suggested to control the temperature of specimens in or on a solid support by using infrared radiation or microwave.

US patent No. 5,023,187 relates to a device for accelerated treatment of thin tissue specimens on microscope slides. The microscope slides are placed in a slide holder, and energy is supplied to the surface of the slides in the form of infrared radiation.

US patent No. 5,244,787 relates to a method for retrieval of antigens from formalin-fixes, paraffin-embedded tissues and their subsequent staining by immunohistochemical techniques comprising a step of immersing the tissue sections in water and heating the water using microwave.

Working with infrared radiation and microwave requires special equipment, since exposing to infrared radiation and microwaves is injurious to health, and consequently,  
5 infrared radiation and microwave treatment should be avoided, if possible.

DE 196 28 8(73) discloses an ELISA test. The test includes a substrate in the form of a cylinder coated on its inner  
10 surface with a binding agent e.g. a binder for an antigen. The cylinder may be of a metal which can be heated by use of induction heat for controlling the temperature during the analysis, and which can be moved using a magnet for use in automatics analysis equipment. The cylinder may be  
15 placed in a well of a microtiter plate, and filled with liquid comprising e.g. an antigen.

In the art of carrying out quantitative tests of biological specimens it is generally preferred to fix the specimen or  
20 capture probes for the specimen onto a carrier e.g. a latex particle or a micro slide. Usually a practitioner carries out a number of different test of a biological specimen in order to get sufficient information about the patient from which the biological specimen has been taken for the doctor  
25 to make a diagnose. Some of the tests include one or more steps where heating or heat control of the specimen is necessary, other tests do not require heat control. Generally, it is a requirement from the practitioner that the specimens can be fixed on the same type of carrier  
30 irrespectively of the test to be carried out. Thus, it is not acceptable that the specimens or the capture probes for tests requiring heat control should be fixed on a metal carrier and other specimens or capture probes for tests without heat control should be fixed on e.g. glass slides,  
35 on the inner surface of a well or on latex beads.

The object of the present invention is to provide a method of controlling the temperature of a specimen, in particular a biological specimen, which method does not suffer from the drawbacks mentioned above.

5

A further object is to provide a method of controlling the temperature of a biological specimen fixed to a carrier or a specimen captured or about to be captured by capture probes which are fixed to a carrier such as a micro slide or latex beads or a well, which method provides a fast regulation of heat, is simple and precise, and also, at the same time is not hazardous to health.

10

15

Yet a further object is to provide equipment for carrying out such methods.

This and other objects are provided by the methods defined in the claims.

20

25

30

35

According to the method of the first aspect of the invention, the specimen to be subjected to a heat control or heat treatment is fixed to a carrier, or the specimen is in liquid form in contact with a carrier onto which capture probes for capturing said specimen are fixed, which carrier is removably placed in, on, or under a solid support member. The solid support member comprising a conducting material in that it is either totally or partially prepared from an electrically conducting material or the solid support member is equipped with an electrically conducting material by bringing one or more pieces of electrically conducting material into physical contact with the solid support member during the heat treatment step. The thickness of the electrically conducting material should preferably be sufficiently large to make it possible to generate a heat of 35 °C, more preferably 50 °C, even more preferably 100 °C and in certain

10034357-011702



situations even 110 °C in the electrically conducting material itself.

5 In principle any method of fixing a specimen or capture probes to a carrier may be used. The specimen may e.g. be fixed to the carrier by use of formalin, heat, ethanol or it may be chemically immobilized. The capture probe may preferably be fixed to the carrier by chemically immobilizing.

10

The capture probes may be any kind of capture probes, which are able to capture the specimen. The capture probes may preferably be selected from the group consisting of antibodies, DNA, PNA and streptavidin. By the terms "capture probes, which are able to capture the specimen" and "capture probes for capturing said specimen" are meant capture probes which is able to bind to the specimen or a part of the specimen. Such capturing probes normally are able to selectively recognize specific areas or markers of the specimen and bind to these, whereby the specimen or parts of the specimen will be captured.

25 By the term "a specimen in liquid form" is meant any liquid material comprising a specimen in solution, in dispersed or suspended form. A specimen in liquid form may e.g. be a cell suspension or a lysate.

30 The larger the surface area of the electrically conducting material is, the larger is the transfer of heat to the specimen. The surface area of the electrically conducting material should therefore preferably be at least 0.5 cm<sup>2</sup>, more preferably at least 3 cm<sup>2</sup>.

35

10031357.011702

The electrically conducting material may, as indicated, be in direct contact with the specimen on the carrier. However, in most situations, it is preferred that the electrically conducting material and the specimen are not in physical contact. When the specimen are in liquid form and about to be captured by capture probes fixed to the carrier some of the area of the specimen may be in direct contact with the electrically conducting material whereas other areas is in indirect contact with the electrically conducting material. It is preferred that the electrically conducting material is in indirect contact with most or all of the specimen which means that a layer of heat conducting material is placed between the electrically conducting material and the specimen or the capture probes on the carrier, so that the electrically conducting material is in contact with the layer of heat conducting material e.g. the liquid with the sample or a reaction liquid, which heat conducting material is in direct contact with the capture probes or the specimen. The distance between the electrically conducting material and the capture probe or the specimen should, however, be sufficiently short to allow a fast heating of the specimen e.g. the specimen captured or about to be captured by the capture probes. The more heat conducting material there is between the electrically conducting material and the specimen/capturing probes, the longer it takes for the generated heat to be transmitted to the specimen.

It is preferred that the heat conducting material is either constituted by the carrier or a liquid, such as a treatment liquid e.g. an analyte or a cleaning liquid e.g. water, applied onto the specimen, or a specimen in liquid form on the carrier.

10034337.011700

5 The solid support member is subjected to an oscillating magnetic field, whereby the electrically conducting material generates heat, which heat is transmitted to the specimen. The distance between the specimen or the capture probes before or after having captured the specimen, and the electrically conducting material is preferably between 5 nm and 1 cm, more preferably 10 nm and 1 mm, and even more preferably between 1 and 300  $\mu$ m. The distancing material is constituted by a heat-conducting material which is defined as a substantially solid or liquid material. The distancing, heat-conducting material may be constituted by a wall of the solid support, or more preferably by the carrier or a treatment liquid for the specimen or the specimen in liquid form.

15 A temperature sensor may preferably be placed near to or in contact with the specimen to register the temperature. The temperature sensor may e.g. be placed in direct contact with the electrically conducting material. In a preferred embodiment an IR temperature sensor is placed

20 sufficiently close to the electrically conducting material to measure the temperature of the electrically conducting material. In this preferred embodiment it is even more preferred that the IR temperature sensor is

25 placed sufficiently close to a non-covered area of the electrically conducting material to measure the temperature of this area of the electrically conducting material. By "non-covered area" means that this area is not covered with a liquid or a solid mass. The

30 temperature sensor may be a part of a regulation system regulating the oscillating magnetic field in relation to a wanted temperature of the specimen and the obtained temperature. Such regulation systems are in general known to a skilled person.

10034357.01170

In a preferred embodiment of the present invention the temperature of the conducting material is registered by the inductor, e.g. in the form of an induction coil. By registration of the feed back from the heat induction of the conducting material placed in the oscillating magnetic field, the temperature of the electrically conducting material and thereby the temperature of the specimen placed closed thereto, e.g. in direct contact with the conducting material, can be calculated, and the oscillating magnetic field may be regulated depending on the calculated temperature and the wanted temperature of the specimen. In other words, in this embodiment the inductor has two functions, viz. to generate an oscillating magnetic field, and to measure the feed back from the heat induction of the conducting material, whereby a regulating device can determine the temperature and regulate the field strength of the oscillating magnetic field. The method of calculating the temperature of a electrically conducting material in an oscillating magnetic field by use of the feed back from the heat induction of the conducting material is known to a skilled person.

During the heat treatment step the carrier is placed in, on or under the solid support. This means that the carrier is placed in such relation to the solid support that the heat generated in the electrically conducting material of the solid support can be transferred to the specimen fixed on the carrier or the capture probes with or without captured specimen.

The solid support member may in principle be of any type, such as a microtiter plate, a cartridge, a cartridge for a microscope slide, a test tube, a probe, a membrane, or a filter.

The carrier may preferably be adapted for carrying small samples e.g. solid specimen having a size less than 3 cm<sup>3</sup>, preferably less than 0.1 cm<sup>3</sup>, immobilized specimen immobilized onto an area of less than 5 cm<sup>2</sup>, preferably less than 2 cm<sup>2</sup>, or capture probes spread over an area of less than 5 cm<sup>2</sup>. The carrier may preferably be a microscope slide, a particle, a bead or a probe.

The specimen is fixed to the carrier during the heat treatment step, or the capture probes is fixed to the carrier during the heat treatment step. In the latter case the specimen or parts of the specimen may be captured by the capture probe before or during the heat treatment step, which means that the specimen comes into close contact with the carrier.

Solid support members as well as carriers of the above type, but without electrically conducting materials, are well known in the art. The type of solid support member and carrier is selected depending of the type of specimen and on the type of heat control and treatment to which the specimen should be subjected.

Solid support members as described in the prior art publications US patent No. 5,068,091, US patent No. 5,338,358, WO publication 94/18539, WO application No. PCT/DK98/00580, WO publication No. 92/01919, WO publication No. 97/03827, US Patent No. 5,232,667, US patent No. 5,244,787, US patent No. 5,023,187 are in general useful in the present method, when these support members are modified by equipping the support member with an electrically conducting material.

When the specimen is a solid specimen, an immobilized specimen or a specimen in liquid form, and the carrier is a particle, a bead or a probe, the solid support member

may preferably be a microtiter plate, a test tube or a similar member comprising a well.

Any type of test tube or any type of microtiter plate  
5 comprising at least one or two wells may be used.

A well in a test tube or a microtiter plate may have any shape. Normally, a well is shaped as a hollow well formed by a circumferential wall having a concave or plane  
10 bottom. The well of the test tube or one of the wells of the microtiter plate comprises a conducting material. The conducting material may be in the form of a solid piece of electrically conducting material placed in the well or in the form of one or more solid pieces or particles of  
15 conducting material incorporated in the wall or the bottom of the well. The electrically conducting material may also be loosely placed in the well, e.g. in the form of bead shaped pieces including electrically conducting material.

20 If the solid support member is a microtiter plate, the microtiter plate should preferably comprise at least 5 wells and preferably at least 10 wells. All or at least a number of the wells, e.g. every second or third of the  
25 wells, may preferably be equipped with electrically conducting materials. The amount and type of electrically conducting materials in each well, or incorporated in the wall or the bottom of each well may vary from each other. These embodiments are particularly preferred when pieces  
30 of electrically conducting material are loosely placed in the wells. By using different pieces of electrically conducting material i.e. pieces of electrically conducting material having different surface areas, the temperature obtained in each well may vary, when  
35 subjecting the microtiter plate to an oscillating magnetic field.

When the solid support member is a test tube, it is most preferred that the electrically conducting material is fixed on the inner side of the wall or loosely placed in the well in form of beads, powder, disk or sticks.

When the specimen is in a solid, semi-solid or high-viscous liquid form, or in the form of a cell suspension, and the carrier is a microscope slide or a similar plate, the solid support member may preferably be a cartridge or a cover plate for the microscope slide.

A useful cartridge may comprise at least one chamber encompassed by a cartridge wall, and one or more pieces of electrically conducting materials. In the heat control step, the microscope slide with the specimen is placed in the chamber, and the cartridge is subjected to an oscillating magnetic field. The chamber should preferably comprise at least one access opening for introducing the microscope slide, and for passing a processing fluid into and out of the chamber for treating the specimen. The conducting material may e.g. be in the form of a solid piece of conducting material placed on the inner side of the cartridge wall, or in the form of one or more solid pieces or particles of conducting material incorporated in the wall of said cartridge.

A useful cartridge may e.g. be selected among the cartridges described in US patent No. 5,068,091, US patent No. 5,338,358, WO 94/18539 or WO application No. PCT/DK98/00580 modified by incorporating an electrically conducting material. These cartridges are all adapted to be used in combination with either one or several microscope slides, on which slide or slides the specimen or specimens are placed. The slide or slides are inserted into the cartridge.

As indicated above, it is preferred that the solid support member is a cartridge and that it is used in combination with at least one microscope slide, and more preferred a cartridge in combination with one microscope slide as the carrier. The cartridge comprises preferably a chamber for each slide which it is adapted to be combined with, and at least one access opening for introducing and withdrawing each of these slides. Furthermore, the cartridge comprises at least one opening for passing a processing fluid into and out of the chamber or chambers.

The electrically conducting material may be placed on, or incorporated into the cartridge. The electrically conducting material may e.g. be in the form of a solid piece of conducting material placed on the inner side of the cartridge wall or more solid pieces or particles of conducting material incorporated in the wall of the cartridge.

A particularly preferred cartridge in combination with one or more microscope slides as carrier is a cartridge in combination with a microscope slide, where the cartridge comprises a housing having a cavity therein and an aperture providing access for the introduction of the microscope slide into the cavity, so as to divide it in two compartments when the microscope slide is inserted therein. One of the compartments (called the first one) is defined by the sample bearing surface of the slide, an inner surface of the cavity and spacing means there between of such size, form and configuration that the dimension of the first compartment perpendicular to the sample bearing surface of the support member and the inner surface of the cavity is of capillary dimensions. The other compartment (called the second compartment) is defined by opposite



surface(s) to the sample bearing surface of the slide and the remaining inner surface(s) of the cavity. The cavity is provided with elastical means engaging said support member and biasing the sample bearing surface of the support member against said spacing means in the first compartment.

This cartridge is described in further details in WO application No. PCT/DK98/00580. This cartridge is further equipped with electrically conducting material e.g. in the form of a solid piece of conducting material placed on the inner side of the cartridge wall or more solid pieces or particles of conducting material incorporated in the wall of the cartridge. Most preferably the electrically conducting material is in the form of a solid piece of conducting material placed on the inner side of the cartridge wall of the first compartment. This first compartment cartridge wall comprises an opening allowing direct contact to the solid piece of conducting material for measuring the temperature of this material.

In another embodiment, the solid support member is constituted by a cover plate for a microscope slide.

When the solid support member is constituted by a cover plate for a microscope slide, the electrically conducting material may be placed on or incorporated into the cover plate. The slide may be a simple slide of glass, polymer or other electrically non-conducting materials. The cover plate may in principle have any shape e.g. a shape as a microscope slide which further comprises the electrically conducting material. Such sets of slides, but without electrically conducting materials, are described in US 4,731,335, and the sets of slides in modified form (equipped with electrically conducting materials) as well as the slide holder may be used in the method of the present invention.

Alternatively, the cover plate may have any other shape provided that it comprises a surface adapted to cover a specimen on the surface of a carrier e.g. in the form of a microscope slide. A useful combination of a microscope slide and a cover plate which naturally should be modified (equipped with electrically conducting materials) is e.g. described in WO 96/21142.

In all the above embodiments, including a microscope slide as carrier, it is preferred that the slide is a transparent slide, at least on the central part of the slide. Ordinary microscope slides of glass may preferably be used.

The electrically conducting material may be any type of material which is able to generate heat when subjected to an oscillating magnetic field. Preferred electrically conducting materials are non magnetic metals, more preferably a metal selected among iron, carbon steel, stainless steel, brass, copper, aluminium, silver, gold, platinum, nickel, zinc, pewter or alloys thereof. The electrically conducting material may preferably be in the form of a plate element e.g. a disk which is composed of two layers, a first layer of a highly inductive material e.g. iron, carbon steel or stainless steel, and a second layer of a highly heat conducting material e.g. copper, or silver. The layer of a highly heat conducting material should preferably be turned against the carrier. In a preferred embodiment the electrically conducting material is in the form of a plate element composed of two layers, a first layer of iron and a second layer of silver, wherein the layer of iron is relatively thick compared to the layer of silver e.g. 3-10 times thicker.

The electrically conducting material should preferably have a large surface, relative to the amount of

- electrically conducting material in order to provide a fast heat regulation, including allowing a fast cooling of the specimen. When the electrically conducting material is in the form of one or more pieces, this or
- 5 these one or more pieces may be in the form of one or more plates, having a length, a width and a thickness wherein the length and the width, respectively, are at least 10 times the thickness.
- 10 The amount of electrically conducting material in a solid support depends on the type and size of the support as well as the type and size of specimen(s) and the choice of electrically conducting materials. In most situations, the solid support member preferably comprises between 10
- 15 and 100.000 mg of a conducting material. A skilled person may determine the optimal amount by carrying out a few tests.
- 20 When the electrically conducting material is in the form of powder incorporated into the material constituting the whole or a part of the solid support member, this material wherein the powder is incorporated, is preferably a polymer material e.g. as mentioned later on.
- 25 The amount of electrically conducting material should be sufficiently high to raise the temperature of the specimen when the solid support is subjected to the oscillating magnetic field.
- 30 Generally the carrier is preferably at least partly of a glass material or a polymer material. At least a part of the glass material or the polymer material in direct contact with the specimen is preferably transparent in order to make the specimen easily visible. The solid
- 35 support member may preferably be partly of a glass material or a polymer material.

If the carrier is at least partly of a polymer material, this polymer material may in general be of any type of polymer that does not result in an unwanted interference with the specimen. The polymer material for the support member and the carrier may preferably be selected from synthetic and natural polymers such as polystyrene, polyethylene, polyurethane, polyethylene terephthalates, polyvinylacetate, polyvinyl-chloride, polyvinylpyrrolidone, polyacrylonitrile, polymethyl-methacrylate, polytetrafluoro-ethylene, polycarbonate, poly-4-methylpentylene, polyester, poly-styrene polypropylene, cellulose, nitro-cellulose, starch, polysaccharides, natural rubber, butyl rubber, styrene butadiene rubber, silicone rubber and copolymers or mixtures thereof.

It is preferred that the magnetic field is generated by use of an electromagnetic inductor comprising an induction coil in the form of a wire wound into a coil with one or more windings, and a power supply sending alternating current through the coil. Such electromagnetic inductors are generally known to a skilled person. The electromagnetic inductor may have any shape, provided that it is able to generate an oscillating magnetic field, and that the solid support member can be placed in this oscillating magnetic field. The electromagnetic inductor should preferably be able to create a substantially homogenous field or a size which is at least sufficiently large to cover all of the electrically conducting material in a carrier. The size of the field generally depends on the shape of the inductor. The inductor may comprise a movable shelf surrounded by the coil, and on which shelf the solid support member or members may be placed. The movable shelf in the oscillating magnetic field may, when it is moved during the induction heating step, result in a more

evenly distribution of the heat effect of the specimen(s) in the solid support member(s) placed on the shelf.

The power supply may be an A.C. power supply, the frequency range is between 50 Hz-500 kHz e.g. 133 - 215 kHz, preferably up to 200 kHz, and the power delivered through said coil is up to about 100 W, preferably between 5 and 75 W, e.g. about 15 or 20, more preferably between 25 and 50 W. If many specimens are to be heat controlled at the same time, the power delivered through said coil may be higher, e.g. up to about 1000 W.

In the method according to the invention, it is preferred that the specimen is a biological specimen. However, the method may in general be used for any type of biological, chemical and physical tests on organic and inorganic materials, preferably on organic materials.

The method is particularly useful for testing or treating vegetable or animal specimens, preferably human specimens e.g. cellular specimens of skin, bones, blood or muscles.

Any type of test procedures including a heat control step may be carried out using the claimed method. Examples of test procedures are described. Solid support members as described in the prior art publications US patent No. 5,068,091, US patent No. 5,338,358, WO publication 94/18539, WO application No. PCT/DK98/00580, WO publication No. 92/01919, WO publication No. 97/03827, US patent No. 5,232,667, US patent No. 5,244,787 and US patent No. 5,023,187 may be used. Preferred procedures are immunohistochemical or/and in situ hybridisation.

In the method according to the invention, the step of heat control includes heating the specimen to a

temperature of between 25 and 110 °C, preferably between 30 and 95 °C, more preferably between 35 and 85 °C.

In another preferred embodiment, the specimen is heated and maintained at a constant temperature for a period of 1 minute and up to 1 week, preferably for up to 1 hour. The specimen may e.g. be incubated at 35 °C for 24 hours using this method.

10 The step of a procedure including heat control may also be drying, and/or fixing of the specimen at an elevated temperature (e.g. a temperature above 30 °C) or  
15 subjecting the specimen to a reaction step at an elevated temperature (e.g. a temperature above 30 °C). The reaction step may e.g. comprise capturing a specimen, baking the specimen (e.g. fixing of tissue onto a slide), exposing the specimen to antigen retrieval, denaturing the specimen, hybridising the specimen, dewaxing (deparafinating) the specimen and washing the specimen.

20 The method according to the invention in its first aspect provides a fast and precise heat regulation of a specimen on a carrier with a very low risk of overheating the specimen, and furthermore the practitioner does not need  
25 knowing if the specimen should be subjected to a heating step or not prior to fixing the specimen onto the carrier. Thereby the method can be used in a very flexible manner and is easy to incorporate into normally used procedures.

30 The present invention in its first aspect also relates to the solid support member as well as the use of said solid support member as described in further details above.

35 The invention in its second aspect relates to a method for controlling the temperature of a specimen or a

10031357-011702

capture probe for a specimen with or without captured specimen fixed or immobilized onto one or more micro beads. The beads should have a size sufficiently small to be flowable in a liquid fluid, preferably water.

5 Preferably, the beads should have an average size of between 1-1.000.000 nm, preferably 1000 to 100.000 nm, more preferably 25-10.000 nm.

10 The bead or beads may be partly or totally of an electrically conducting material. Preferably, the beads comprise a core of metal and a polymeric cover, wherein the core preferably may constitute 50 to 98 volume-% of the beads. The electrically conducting material may be as described above in the first aspect of the invention.

15 The specimen may be any type of specimen which can be fixed or immobilized onto the bead. Methods of fixing or immobilizing such specimen are well-known in the art.

20 The test including the heating step may be as described above for the first aspect of the invention.

25 The bead or beads are placed in a liquid e.g. a treatment liquid, and the method includes the step of carrying the one or more micro beads through an oscillating magnetic field for generating heat by use of a flow stream in the liquid. The oscillating field may be generated as described above for the first aspect of the invention.

30 Assays on beads in a flow system are generally known in the art. In a preferred method lyzed specimen is mixed with a mixture of a detection probe and the metal containing bead pre-coated with a specific capture probe or the lyzed specimen is mixed with a metal containing

35 bead pre-coated with a specific molecular beacon. The specific probes can be selected by a person skilled in

the art using normal and well-known procedures. The complete mixture is then carried through a flow system e.g. a flow cytometer, which contains an induction coil surrounding or close to the flow path, and located just prior to the detection system of the flow system. The beads are located inside the oscillating magnetic field generated by the induction coil for a sufficient time to heat the beads. The heat is used to insure that only specific capture is detected in the flow cell.

10

When the specimen has been treated with a liquid, the liquid may be separated from the beads carrying the specimen by capturing the beads with a magnet.

15 Fig. 1 shows a cartridge with a microscope slide in cross-section.

Fig. 2 shows a cartridge similar to the cartridge of fig. 1.

20

Fig. 3 shows a microtiter plate 11 in a perspective view.

Fig. 4 shows a test tube seen in cross-section.

25 Fig. 5 shows a microscope slide in combination with a cover plate in cross-section.

Fig. 1 shows a cartridge 1 with a traditional microscope glass slide 2 in cross-section. A specimen in the form of a tissue section 3 is fixed to the upper surface of the slide 2. The cartridge comprises a cavity, wherein the slide is introduced through access opening A. The cavity is divided into a first and a second compartment 6,7. An elastically protruding flange 4 is placed in the bottom of the cartridge cavity in the second compartment. A metal membrane 5, preferably composed of carbon steel, is



fixed in the upper sealing of the cavity. The upper wall of the cartridge has an opening 1a allowing direct access to the metal membrane for measuring the temperature of the metal. In use, a treatment liquid is introduced into the first compartment and the cartridge is introduced into an induction coil 8. When an oscillating magnetic field is created, the metal film will generate heat and the heat will be directly conducted to the specimen.

Fig. 2 shows a cartridge similar to the cartridge of fig 1. Above the cartridge 1 is placed an induction coil 9. When the first compartment is filled with treatment liquid and an oscillating magnetic field is created, the metal film will generate heat and the heat will be directly conducted to the specimen.

Fig. 3 shows a microtiter plate 11 in a perspective view. Only a number of the wells 12, 12' are shown. Some of the wells 12' of the microtiter plate comprise a metal piece 13 loosely placed onto the bottom of the wells. The substrate comprising the specimen may be an area of the walls of the wells or the substrate may be in the form of particles or beads, which are placed in the wells 12' together with a treatment liquid prior to the heat treatment step. Below the microtiter plate 11 is placed an induction coil 14. When the microtiter plate 11 is subjected to an oscillating magnetic field, heat is generated in the metal 13, and the specimen is heated to a preselected temperature.

Fig. 4 shows a test tube 22 seen in cross-section. The test tube has one well 28 comprising a not shown reaction medium e.g. comprising a cell suspension. A probe 21 comprising an electrically conducting material is inserted into the reaction medium. Capture probes are fixed to not shown beads which are also applied into the

202770 254E001

reaction medium. An electromagnetic induction coil 25 surrounds the test tube. When an oscillating magnetic field is created, the electrically conducting metal generates heat and the heat will be directly conducted to the capture probe whereby influencing the reaction between the capture probes and the cells.

Fig. 5 shows a microscope slide 32a in combination with a cover plate 32b. The microscope slide is an ordinary glass slide or a similar electrically non-conducting slide carrying a specimen 33 on its upper surface. The cover plate is prepared from a similar slide, and comprises further a layer 35 of an electrically conducting metal on its surface turning against the first slide. The microscope slide and the cover plates are sandwiched with the specimen in between. An electromagnetic induction coil 38 is placed sufficiently close to the cover plates to be able to provide an oscillating magnetic field in the cover plate, which plate there generates heat, and the specimen is heated to a pre-selected temperature.

#### EXAMPLES

##### EXAMPLE 1

A cartridge with a microscope slide as shown in fig. 1 containing a carbon-steel membrane with a thickness of 0.05 mm as described above in fig. 1 was filled with 500  $\mu$ l water in the first compartment of the cartridge. The cartridge was placed on an induction coil capable of delivering a maximum of 600 W. Since the cartridge covered only 1/20 of the coil, the energy delivered to the cartridge is expected to be below 30 W. The initial temperature of the water sample in the cartridge was measured to 22°C using a temperature sensor placed in the

first compartment of the cartridge. The induction generator was turned on and the temperature followed. After 60 seconds, the temperature reached 72°C.

## 5 EXAMPLE 2

10 A cartridge as shown in fig. 1 with a 0.25 mm thick carbon-steel membrane was inserted into a surrounding induction coil (60 W). The first compartment of the cartridge was filled with 200 µl water. The water was heated with the induction coil to 80°C in 20 sec and kept at this temperature using a temperature feedback device for 5 min. The heating was then discontinued, and the sample allowed cooling to room temperature.

15

## EXAMPLE 3

20 A cartridge as shown in fig. 1 with a 0.25 mm thick carbon-steel membrane was inserted into a surrounding induction coil (20 W). The first compartment of the cartridge was filled with 200 µl water. The temperature of the water was followed by a sensor placed in the first compartment, and the temperature of the metal membrane was measured by an IR temperature sensor placed near the membrane above the opening 1a in the upper wall of the cartridge. The membrane was heated to 50 °C using the induction coil. After about 38 seconds the temperature of the metal plate was reached and this temperature of the membrane was held constant for 600 seconds using feedback control. The temperature of the water reached a temperature of about 48 °C after 80 seconds and this temperature was kept constant until the oscillating magnetic field was turned off.

35

## EXAMPLE 4

A traditional microscope slide with a specimen in the form of a fixed metaphase spread of human blood cell was first manually pre-treated with a proteolytic enzyme for 10 minutes and then the specimen was dehydrated with cold ethanol for 6 minutes. The slide was inserted into a cartridge as shown in fig. 1. The metal membrane of the cartridge had a thickness of 0.25 mm and a width and length of about 2x3 cm. 200 µl probe mixture from the DAKO Telomere PNA FISH KIT (product No. K 5326) was added into the first compartment of the cartridge. The cartridge with the slide was inserted into an induction coil (20 W) equipped with a temperature control unit comprising an IR temperature sensor placed near the membrane above an opening in the upper wall of the cartridge. The membrane was heated to 80 °C within 150 seconds and was kept at this temperature for 3 minutes. The induction coil was turned off and the specimen was allowed cooling to room temperature for about 30 minutes. The remaining probe mixture was removed from the first compartment and the slide was washed at room temperature. Stringent wash was carried out using 3 times 200 µl wash buffer which in each wash was heated to 55 °C for 5 minutes by turning on the induction coil. Finally the slide was removed from the cartridge and dehydrated using cold ethanol. The dried specimen was mounted in antifade with DAPI according to the DAKO Telomere PNA FISH KIT. No sign of local overheating of the specimen could be observed. The result was equivalent to the fully manual procedure.

## EXAMPLE 5

Specimen was immobilized onto latex beads and added to each well of a microtiter plate together with water as shown in fig. 3. The water was heated to 85°C for 10 min by induction heat and controlled by a temperature control device. No sign of local overheating of the specimen was observed.

## 10 EXAMPLE 6

Beads with a metal core of 1  $\mu\text{m}$  and a latex coating containing a capture probe was placed in a tube and incubated with a mixture of a complementary oligonucleotide labelled with FITC and a mismatched oligonucleotide labelled with rhodamine. The beads were heated by applying an inductive field. Then the beads were fixed in the tube using an electro magnet, and the remaining components were poured out and washing buffer was added to the well. The beads were released from the magnet and thoroughly mixed into the washing buffer and stringently washed by applying a new round of induction field. The resulting particles were analysed by flow cytometry and florescence microscopy and it was verified that there was a clear discrimination between the complementary and the mismatched oligo target.

## EXAMPLE 7

30 A cartridge as shown in fig 1 with a 0.25 mm thick Fe membrane coated with 50  $\mu\text{m}$  Ag on the inner surface i.e. the surface turning against the first compartment of the cartridge was inserted into a surrounding induction coil made up by 2 individual coils which together were capable of delivering up to 20W. The first compartment of the

cartridge was filled with 200  $\mu$ l hybridization buffer. The temperature of the membrane as well as of the buffer was measured as described in example 3. The buffer was heated with the induction coils to 55°C within less than 5 20 sec. after initiating the heat generation, and kept at this temperature for 300 sec. using a temperature feedback device. Within another 20 seconds the temperature was raised to 90°C and kept at this temperature for 200 sec. The induction was turned of and 10 during a period of 5 minutes the buffer was removed and new buffer added before the temperature was adjusted to 55 C within 10 sec and kept at this temperature for another 300 sec. The temperature accuracy was determined to be within 3°.

15

202710" 011703

## P a t e n t C l a i m s :

1. A method of controlling the temperature of a biological specimen in indirect contact with a solid support member by using induction heating, said specimen being fixed to a carrier or said specimen being in liquid form in contact with a carrier onto which capture probes for capturing said specimen are fixed, and said carrier being removably placed in, on, or under said support member, said solid support member is a cartridge for a carrier or a cover plate for a carrier and comprising a conducting material, said conducting material being in contact with a layer of heat conducting material, which heat conducting material is in contact with the specimen, and said method comprising a step of subjecting said solid support to an oscillating magnetic field.
2. A method according to claim 1, wherein said solid support member is a cartridge comprising a chamber encompassed by a cartridge wall, said carrier carrying said specimen or said capture probes being placed in said chamber and said chamber being subjected to a magnetic field, said chamber comprising at least one access opening for introducing the carrier, and for passing a processing fluid into and out of the chamber
3. A method according to claim 2 wherein said conducting material is preferably in the form of a solid piece of conducting material placed on the inner side of said cartridge wall, or in the form of one or more solid pieces or particles of conducting material incorporated in the wall of said cartridge.
4. A method according to claim 2 or 3, wherein said carrier is a microscope slide, said cartridge comprising a chamber, and at least one access opening for

introducing and withdrawing said slide, and at least one opening for passing a processing fluid into and out of the chamber, said microscope slide is placed in said chamber, and bears said or said capture probes.

5

5. A method according to claim 1, wherein said solid support member is a cover plate for a microscope slide, said cover plate comprising an electric conducting material, said specimen or said capture probes being fixed onto said microscope slide and placed between said cover plate and said slide when subjecting said solid support to an oscillating magnetic field, said slide preferably being a transparent plate.

6. A method according to any one of the preceding claims, wherein the electrically conducting material is a metal, preferably a non magnetic metal or iron, more preferably a metal selected between carbon steel, stainless steel, brass, copper, aluminium, silver, gold, platinum, nickel, zinc, pewter or alloys thereof.

7. A method according to any one of the preceding claims, wherein the conducting material is in the form of one or more plates, having a length, a width, and a thickness, said length and said width being at least 10 times the thickness.

8. A method according to any one of the preceding claims 1-6, wherein the electrically conducting material is in the form of powder incorporated in a polymer material, the amount of powder being sufficiently high to raise the temperature of the specimen when the solid support is subjected to the oscillating magnetic field.



30

9. A method according to claim 8, wherein said specimen is in the form of a solid specimen, preferably a tissue section or a section of cell blocks.

5 10. A method according to any one of the preceding claims, wherein said solid support comprises an amount of electrically conducting material sufficiently high to raise the temperature of the specimen when the solid support is subjected to the oscillating magnetic field.

10

11. A method according to any one of the preceding claims, wherein said magnetic field is generated by use of an electromagnetic inductor comprising an induction coil and a power supply, and sending alternating current  
15 through said coil.

15

12. A method according to claim 11, wherein said power supply is an AC power supply, the frequency range is between 1 Hz-500 kHz, preferably up to 215 kHz, more  
20 preferably between 50-100 HZ.

20

13. A method according to claim 12, wherein power delivered through said coil is up to about 100 W, preferably about 20 W.

25

14. A method according to any one of the preceding claims, comprising a step of heating the specimen to a temperature of between 25 and 110 °C, preferably between 30 and 95 °C, more preferably between 35 and 85 °C.

30

15. A method according to claim 14, wherein the specimen is heated and maintained at a constant temperature for a period of 1 minute and up to 1 week, preferably for up to 1 hour.

35

30

AMENDED SHEET

Empf.zeit:08/10/2001 15:08

Empf.nr.:1/1 P.111/

16. A method according to claim 14, wherein the specimen is dried and/or fixed at elevated temperature, preferably a temperature above 30 °C.

5 17. A method according to claim 14, wherein the specimen is subjected to a reaction step at elevated temperature, preferably a temperature above 30 °C, said reaction step comprises one or more of the steps capturing the specimen, baking the specimen, exposing the specimen to  
10 antigen retrieval, denaturing the specimen, hybridising the specimen, devaxing the specimen and washing the specimen.

18. A method of carrying out an automatic or semi-  
15 automatic assay of one or more specimens each fixed on a microscope slide, said method comprising the steps of

- 20 i) placing the microscope slide in a cartridge comprising a chamber encompassed by a cartridge wall, said cartridge comprising an electrically conducting material in the form of a solid piece of conducting material placed on the inner side of said cartridge wall, or in the form of one or more solid pieces or particles of conducting  
25 material incorporated in the wall of said cartridge,
- ii) placing the cartridge in an induction coil and sending alternating current through said coil to generate a magnetic field.

30

19. A method according to claim 18 comprising an automatic or semi-automatic assay of two or more specimens, said method comprising the steps of

35

- iii) placing each microscope slide individually in a cartridge comprising a chamber encompassed by a cartridge wall, said cartridge comprising an electrically conducting material in the form of a solid piece of conducting material placed on the inner side of said cartridge wall, or in the form of one or more solid pieces or particles of conducting material incorporated in the wall of said cartridge,
- iv) placing each cartridge individually in an induction coil and sending alternating current through said coil to generate a magnetic field.

20. A solid support member in combination with a carrier for a specimen or capturing probes for a specimen for testing or treating a specimen of biological material, said support member preferably being at least partly of a glass material or a polymer material and said support member comprising an electrically conducting material on the surface turning against the side of the carrier carrying the specimen.

21. A solid support member in combination with a carrier according to claim 20, said support member being at least partly of a polymer material selected from synthetic and natural polymers such as, polystyrene, polyethylene, polyurethane, polyethylene terephthalates, polyvinyl acetate, polyvinyl chloride, polyvinyl-pyrrolidone, polyacrylonitrile, polymethyl-methacrylate, polytetrafluoroethylene, polycarbonate, poly-4-methyl-pentylene, polyester, polystyrene polypropylene, cellulose, nitro-cellulose, starch, polysaccharides, natural rubber, butyl rubber, styrene butadiene rubber, silicone rubber and copolymers or mixtures thereof.

22. A solid support member in combination with a carrier according to claim 21, wherein an electrically conducting material is incorporated into the polymer material of the support member.

5

23. A solid support member in combination with a carrier according to claim 22, wherein the electrically conducting material is in the form of powder incorporated in the polymer material, the amount of powder and the particle size of the powder being sufficiently high to provide the material with electrically conducting properties.

10

24. A solid support member in combination with a carrier according to any one of the preceding claims 20-23, wherein the electrically conducting material is a metal preferably a non magnetic metal or iron, more preferably a metal selected between carbon steel, stainless steel, brass, copper, aluminium, silver, gold, platinum, nickel, zinc, pewter or alloys thereof.

15

20

25. A solid support member in combination with a carrier according to any one of the preceding claims 20-22 and 24, wherein the electrically conducting material is in the form of one or more plates, having a length a width and a thickness, said length and said width being at least 10 times the thickness.

25

26. A solid support member in combination with a carrier according to any one of the preceding claims 20-25, wherein said solid support comprises between 10 and 100.000 mg of an electrically conducting material.

30

27. A solid support member in combination with a carrier according to any one of the preceding claims 20-26,

35

wherein the support member is a cover plate for a microscope slide or a cartridge for a microscope slide.

28. A solid support member in combination with a carrier  
5 according to claim 27, wherein said solid support member  
is a cartridge comprising a chamber, for receiving the  
carrier with the specimen or the probes for a specimen,  
and at least one access opening for introducing the  
carrier, and for passing a processing fluid into and out  
10 of the chamber, said conducting material preferably being  
in the form of a solid piece of conducting material  
placed on the inner side of said cartridge wall, or in  
the form of one or more solid pieces or particles of  
conducting material incorporated in the wall of said  
15 cartridge.

29. A solid support member in combination with a carrier  
according to claim 28, wherein said conducting material  
being in the form of a solid piece of electrically  
20 conducting material placed on the inner side of said  
cartridge wall and said cartridge wall comprises an  
opening allowing direct access to the solid piece of  
electrically conducting material.

30. A solid support member in combination with a carrier  
according to claim 27, wherein said carrier is a  
microscope slide, said slide preferably being a least  
partly transparent.

31. A solid support member in combination with a carrier  
and an electromagnetic inductor, said support member  
being a support member according to anyone of claims 20-  
30 and said electromagnetic inductor being able to  
generate a magnetic field.

35

32. A solid support member in combination with an inductor according to claim 31, wherein said inductor comprises an induction coil and a power supply, said coil, preferably being sufficiently large to surround the support member, and said power supply being able to sending alternating current through said coil.

33. A support member in combination with an inductor according to claim 32, wherein said power supply is an AC power supply, the frequency range is between 1 Hz-500 kHz, preferably up to 215 kHz, more preferably between 50-100 HZ.

34. Use of a support member in combination with an inductor according to any one of claims 31-33 for treatment of a biological specimen, preferably a vegetable or an animal specimen, more preferably a human specimen, even more preferably cellular specimens of bones, blood or muscles.

35. Use of a support member according to claim 34 for immunohistochemical procedures or in situ hybridisation.

AMENDED SHEET

Empf.zeit:08/10/2001 15:11

Empf. Nr.: 17/11 P 017

35

Fig. 1

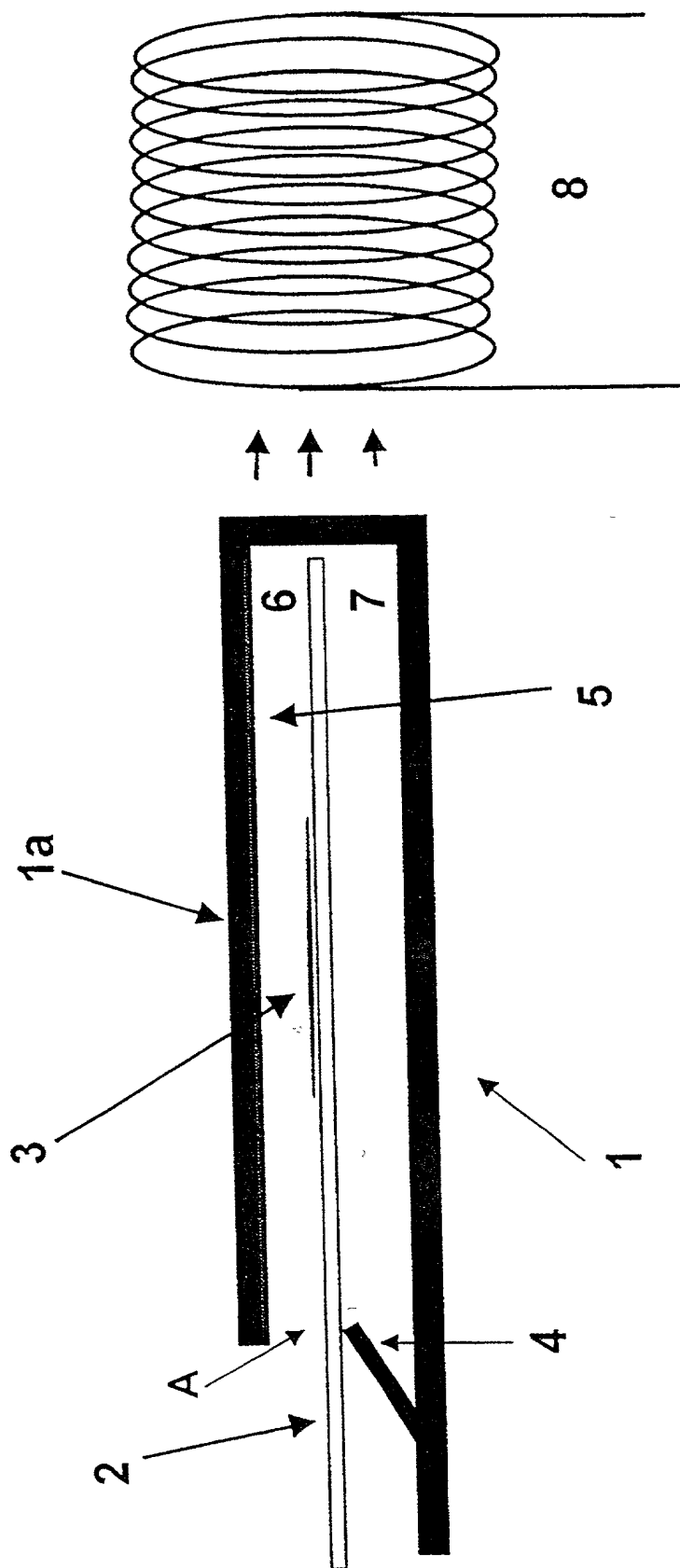


Fig. 2

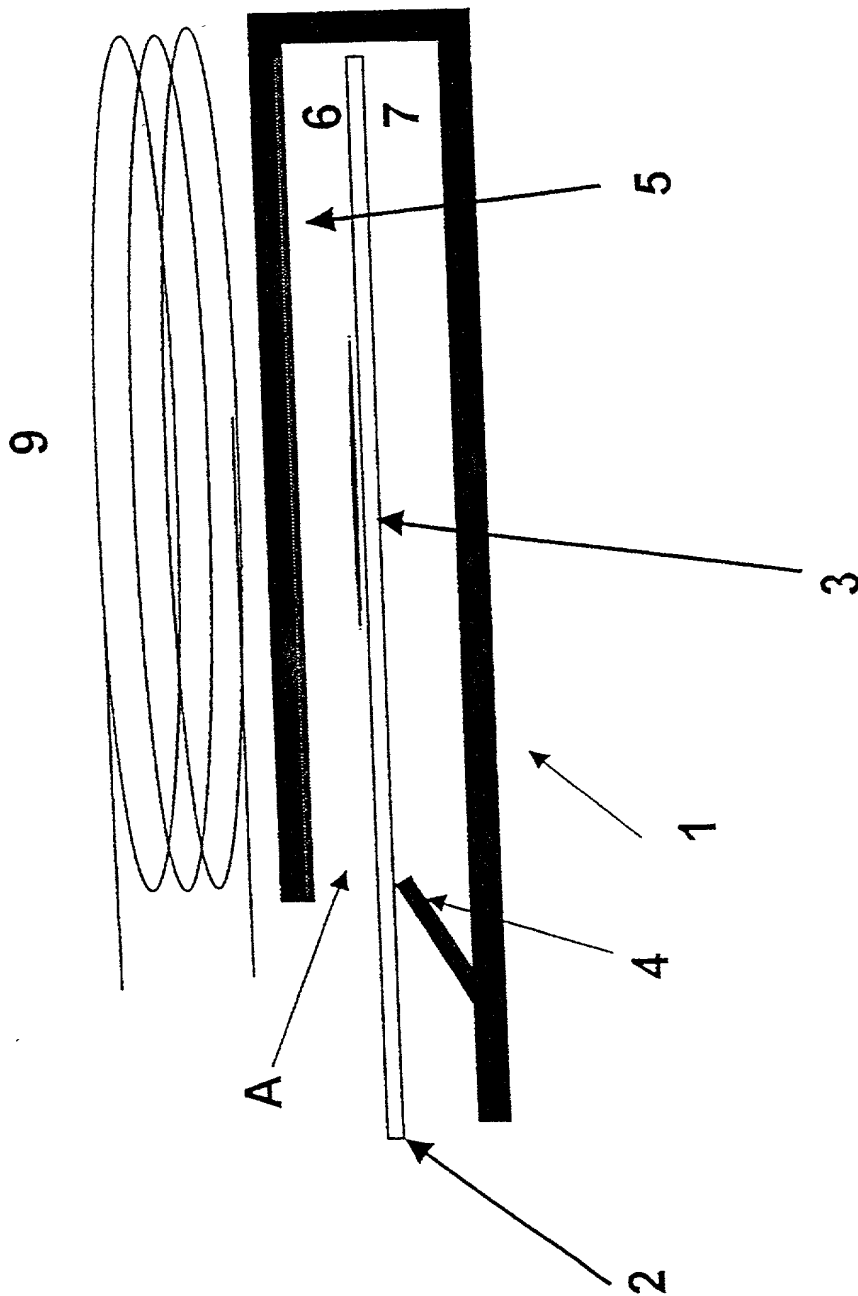




Fig. 3.

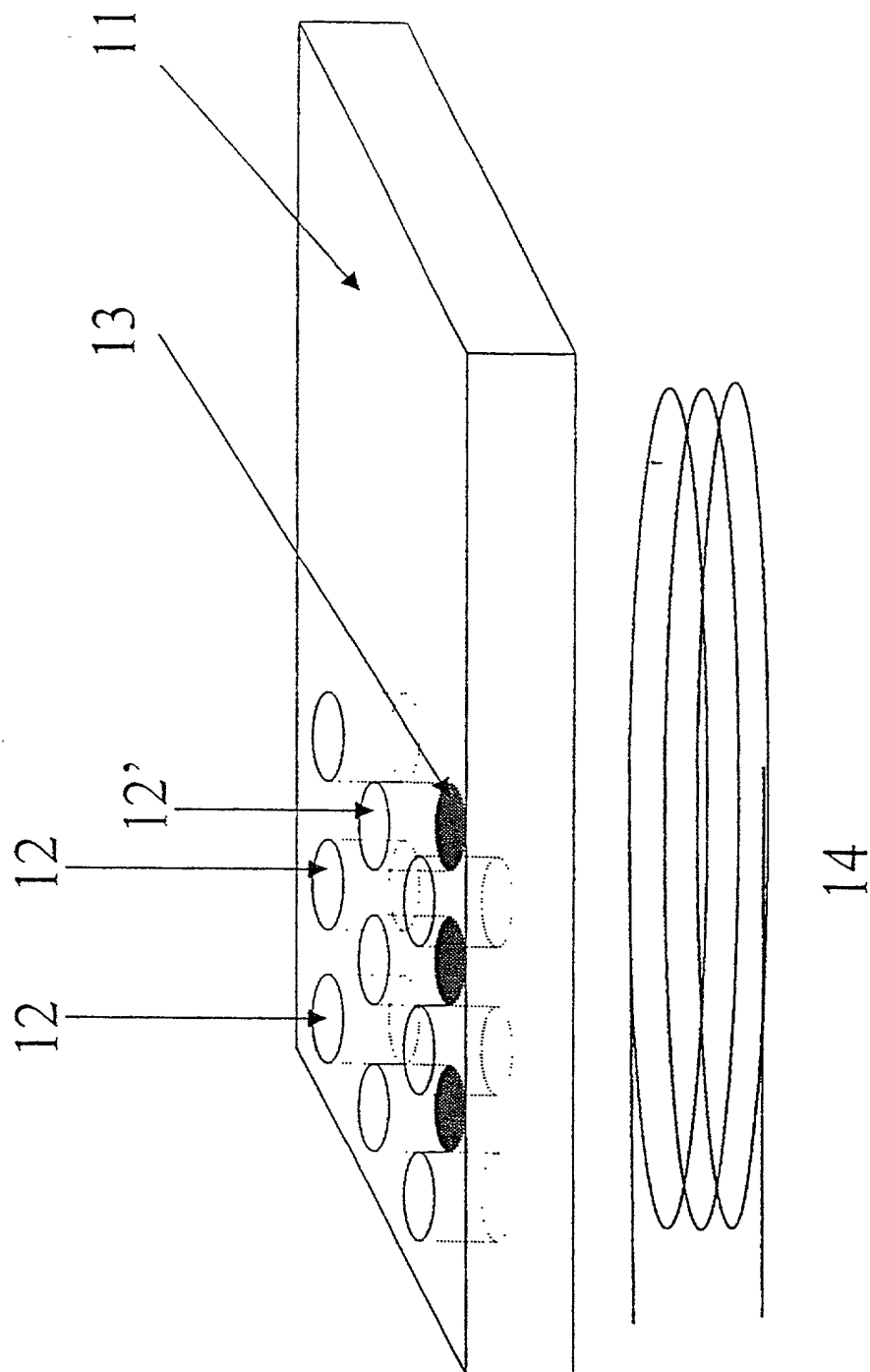


Fig. 4

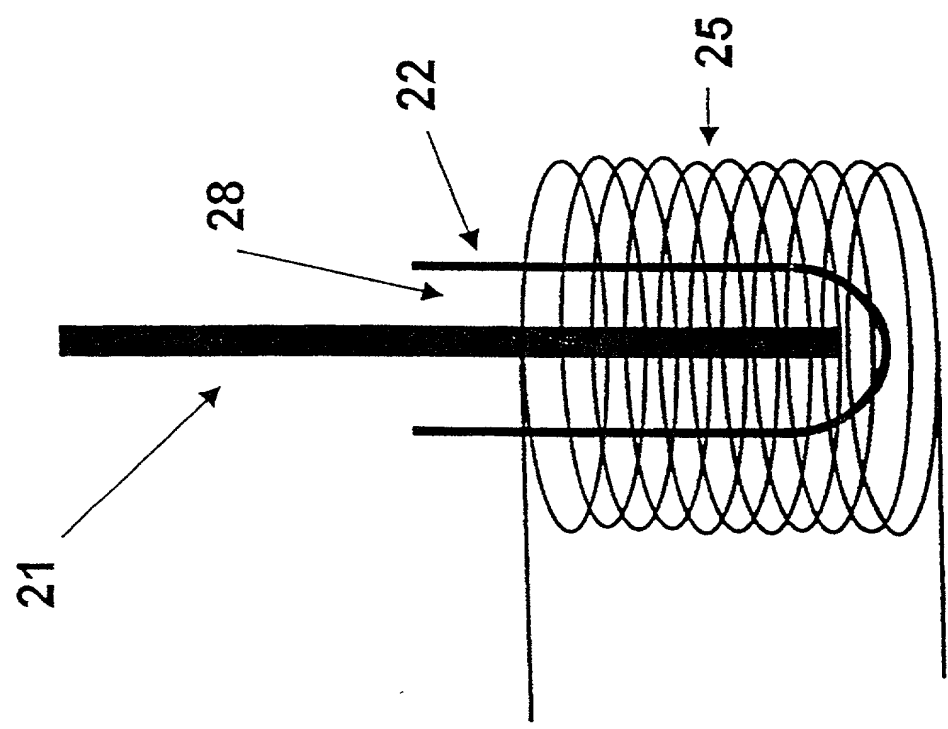
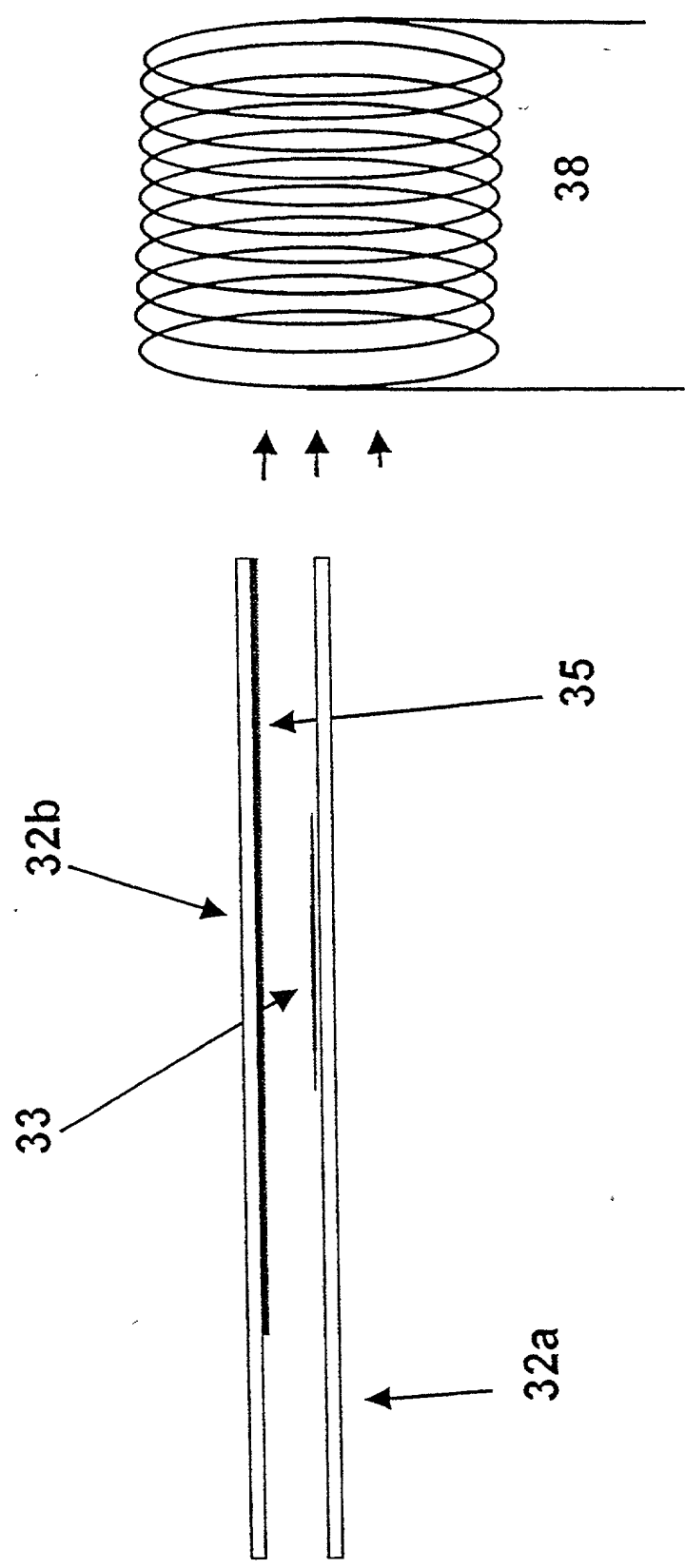


Fig. 5,



## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Declaration for Patent Application

As a named inventor, I hereby declare that:

My residence, mailing address and citizenship are as stated next to my name;

I believe I am the original, first and sole inventor (if only one name is listed) or an original, first and joint inventor (if plural names are listed in the signatory page(s) commencing at page 3 hereof) of the subject matter which is claimed and for which a patent is sought on the invention entitled

A METHOD OF CONTROLLING THE TEMPERATURE OF A SPECIMEN IN OR ON A SOLID

SUPPORT MEMBER

the specification of which (check one)

☐ is attached hereto.

☒ was filed on July 21, 2000 as PCT International Application No. PCT/DK00/00417 which was amended on October 8, 2001; the corresponding U.S. National Phase Application is being filed concurrently herewith and includes a Preliminary Amendment.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 C.F.R. §1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed:

<u>Prior Foreign Application(s)</u>			Priority Not Claimed	Certified Copy Filed?	
		YES		NO	
<u>PA 1999 01044</u> (Number)	<u>Denmark</u> (Country)	<u>21 July 1999</u> (Day/Month/Year filed)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<u>                    </u> (Number)	<u>                    </u> (Country)	<u>                    </u> (Day/Month/Year filed)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<u>                    </u> (Number)	<u>                    </u> (Country)	<u>                    </u> (Day/Month/Year filed)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application(s) listed below.

<u>                                    </u> (Application Number)	<u>                                    </u> (Filing Date)
<u>                                    </u> (Application Number)	<u>                                    </u> (Filing Date)

10031337-01190  
"SECRET"

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information known by me to be material to patentability as defined in 37 C.F.R. 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

_____ (Application Serial No.)	_____ (Filing date)	_____ (Status: patented, pending, abandoned)
_____ (Application Serial No.)	_____ (Filing date)	_____ (Status: patented, pending, abandoned)
_____ (Application Serial No.)	_____ (Filing date)	_____ (Status: patented, pending, abandoned)
_____ (Application Serial No.)	_____ (Filing date)	_____ (Status: patented, pending, abandoned)

As a named inventor, I hereby appoint the attorneys and/or agents associated with  
**Hamilton, Brook, Smith & Reynolds, P.C., 530 Virginia Road, P.O. Box 9133, Concord, Massachusetts 01742-9133, Customer No. 21005,**

and \_\_\_\_\_  
to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Please send correspondence to:

☒ Customer No. 21005  
**HAMILTON, BROOK, SMITH & REYNOLDS, P.C.**  
**530 Virginia Road**  
**P.O. Box 9133**  
**Concord, MA 01742-9133**

or

☐ Address as follows:

Direct telephone calls to: Robert T. Conway, Esq. Telephone No.: 978-341-0036  
Direct facsimiles to: Robert T. Conway, Esq. Facsimile No.: 978-341-0136

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole

or first inventor Lars Winther

Inventor's Signature Lars Winther Date Dec. 13, 2001

Residence Tulipanhaven 80

DK-2765 Smorum, Denmark

**DKX**

Citizenship Denmark

Mailing Address Same as above

Full name of second joint

inventor, if any Kim Adelhorst

Inventor's Signature K. Adelhorst

Date 12/13/01

Residence Solbakken 38

DK-2840 Holte, Denmark

DKX

Citizenship Denmark

Mailing Address Same as above

Full name of third joint

inventor, if any \_\_\_\_\_

Inventor's Signature \_\_\_\_\_

Date \_\_\_\_\_

Residence \_\_\_\_\_

Citizenship \_\_\_\_\_

Mailing Address \_\_\_\_\_

Full name of fourth joint

inventor, if any \_\_\_\_\_

Inventor's Signature \_\_\_\_\_

Date \_\_\_\_\_

Residence \_\_\_\_\_

Citizenship \_\_\_\_\_

Mailing Address \_\_\_\_\_

Full name of fifth joint

inventor, if any \_\_\_\_\_

Inventor's Signature \_\_\_\_\_

Date \_\_\_\_\_

Residence \_\_\_\_\_

Citizenship \_\_\_\_\_

Mailing Address \_\_\_\_\_

2001-12-13 10:01:57 01100